Intelligent Approach for Seamless Mobility in Multi Network Environment

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Abstract: **Seamless interoperability between two dissimilar networks requires handoff from one network to the other. Such handoffs are known as vertical handoffs. Vertical handoff introduces a shift in the approach to handoffs. It deals with handoffs between dissimilar networks, such as from an access point to a base station or vice versa. The integration of diverse but complementary cellular and wireless technologies in the next generation of wireless communication systems requires the design of intelligent vertical handoff decision algorithms to enable mobile users to seamlessly switch network access and experience uninterrupted service continuity anywhere and anytime. This paper provides a vertical handoff decision algorithm that enables wireless access network selection at a mobile terminal. Example shows that our proposed vertical handover algorithm is able to determine the best access network.**

Index Terms: **Vertical Handover, Base Stations, Signal Strength, Unused Bandwidth, Handover Decision Vector.**

I. INTRODUCTION

Along with the development of the mobile technologies as well as the rapid growing number of mobile users, the all-IP backbone which provides the possibility to integrate heterogeneous access networks and technologies becomes the development trend in wireless communications, supporting ubiquitous communications and seamless mobile computing. In a fourth generation (4G) environment, a mobile node equipped with multiple interfaces can handover seamlessly between heterogeneous networks to guarantee the continuity of an ongoing application session such as voice over IP (VoIP) and online gaming. In order to make seamless handover possible, future network devices should be capable to roam freely across various access technologies such as wireless local area networks (WLANs), WiMAX networks, cellular systems, etc [1]. An illustration of a wireless Internet roaming scenario across heterogeneous access networks that involve a personal area network (PAN), a local area network (LAN), a wide area network (WAN), and a cellular system is shown in Fig. 1. However, supporting seamless roaming among heterogeneous networks is a crucial but challenging task, for different access networks having different unique networking characteristics such as mobility, quality-of-service (QoS), and security requirements Thus, existing handover schemes may not be applicable to a pervasive heterogeneous network. A novel approach for network selection is imperative. In order to provide an effective and efficient solution for network selection in a heterogeneous networking environment, we have proposed a vertical handover decision algorithm used to determine the best access network.

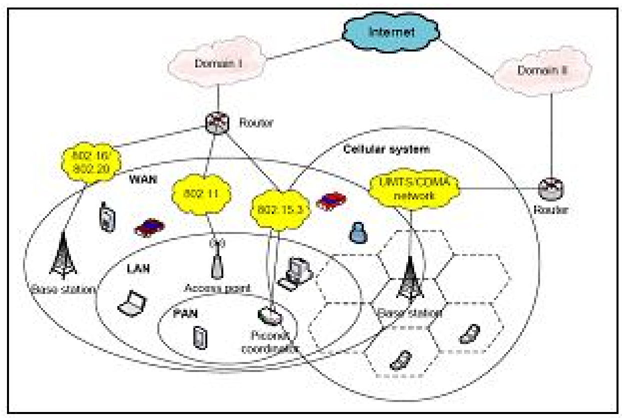

Fig 1: Heterogeneous Wireless Environment

II. SURVEY OF RELATED WORKS

Related work on vertical handoff has been presented in recent research literature. Several papers have addressed designing architecture for hybrid networks, such as the application-layer session initiation protocol (SIP) [2], the hierarchical mobility management architecture proposed in [3], and the *P*-handoff protocol [4]. However, these papers focused on architecture design and did not address the handoff decision point or the vertical handoff performance issues. W. Zhang, in [5], proposes that the vertical handoff decision is formulated as a fuzzy multiple attribute decision-making (MADM) problem. Fuzzy logic is used to represent the imprecise information of some attributes of the networks and the preferences of the user. In [6], Pramod Goyal, and S. K. Saxena proposes the *Dynamic Decision Model*, for performing the vertical handoffs to the “Best” interface at the “best” time moment, successfully and efficiently. They proposed *Dynamic Decision Model* for VHO which adopts a three phase approach comprising Priority phase, Normal phase and Decision phase. Lorenza Giupponi and Jordi Pérez-Romero in [7] propose an innovative mechanism to perform joint radio resource management (JRRM) based on neuron-fuzzy in heterogeneous radio access networks. The proposed fuzzy neural JRRM algorithm is able to jointly manage the common available radio resources operating in two steps.

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The first step selects a suitable combination of cells built around the three available Radio Access Technology (RAT), while the second step chooses the most appropriate RAT to which a user should be attached. The proposed algorithm allows implementing different operator policies as well as technical and subjective criteria, such as the operator and user preferences when performing the RAT selection by means of appropriate inference rules and a multiple decision mechanism. In [8] Liu Xia, et. al proposes a novel vertical handoff decision algorithm for overlay wireless networks consisting of cellular and wireless local area networks (WLANs). The target network is selected using a fuzzy logic-based normalized quantitative decision algorithm. Rami Tawil, et. al in [9] proposes a Trusted Distributed Vertical Handover Decision (T-DVHD) scheme for the fourth generation wireless networks. The main goals of the T-DVHD are to decrease the processing delay and to make a trust handoff decision in a heterogeneous wireless environment. In [10] Imed Lassoued, et. al proposes a novel methodology to evaluate the performance of vertical handoff mechanisms. They proposed a framework that allows to simulate realistic scenarios and to evaluate the entire vertical handoff mechanisms in a coherent manner. The proposed methodology takes into account the users preferences, the applications requirements, the mobile terminal context and the operator constraints. In [11] Ben-Jye Chang and Jun-Fu Chen propose a cross-layer-based polynomial regression predictive RSS approach with the Markov decision process (MDP) based optimal network selection for handoff in heterogeneous wireless networks was proposed. The proposed approach consists of a two-phase procedure. In the first phase, a predictive RSS based on the polynomial regression with a hysteresis algorithm is proposed to predict whether a mobile node moves closer to or away from the monitored wireless network. In the second phase, the handoff cost is determined based on the MDP analysis. The candidate network with the lowest handoff cost is selected as the optimal handoff network.

III. PROPOSED ALGORITHM

In this section we will introduce a new handoff decision strategy. The proposed handoff decision strategy deals with network destination selection. In fig. 2 we show the flow chart of proposed vertical handover decision system. The member ship values for different parameters from different Base Stations are collected. Weight factor for different parameters is calculated. On the basis of Weight factor and membership values the value the vertical handover decision {F.H.D} is calculated for each B.S. Now F[max.] –F [Max.]-1 is calculated. If the difference is greater than FTH than the B.S with highest value is selected as target B.S. And if the difference is less than FTH then there is no need of handoff and the user will remains in current B.S.

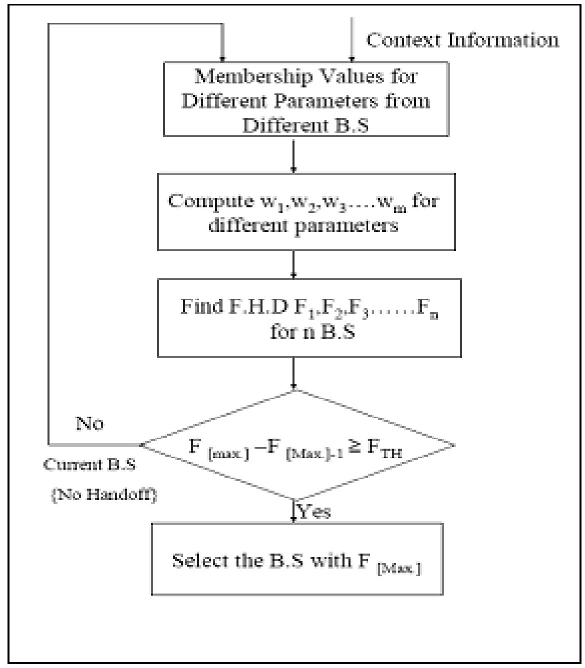

Fig 2: Proposed Algorithm Flow Chart

IV. MEMBERSHIP FUNCTIONS & WEIGHT VECTORS OF CANDIDATE B.S's.

Heterogeneous access through multiple networks is the current trend in the new generation of mobile devices. Managing the complexity of different access schemes, amount of bandwidth and cell coverage in multiple-interface devices is becoming a critical aspect to face. Namely, with multiple-mode mobile devices it is necessary to provide seamless mobility support not only during changes of cells of the same access network, but also during movement between access technologies. So we need vertical handover to use the best characteristic of any technology at one time and another at any other time. This handover decision should be intelligent enough to take the decision spontaneously.

The three input parameters for each of the BS's which we have considered are:

A) The **Signal Strength** which gives us indication about the signal strength.

B) **Unused bandwidth** will gives us the indication about the available bandwidth of the network.

C) **Cost** will give us the information about the cost of the services used.

Figure 3, 4 and 5 shows the membership functions for these above said input parameters. Each input parameter has three variables.

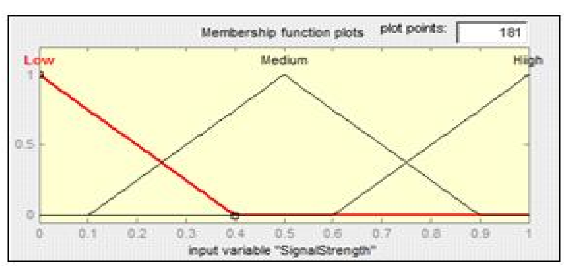

Fig 3: Member Ship Function for the Input Variable Signal Strength

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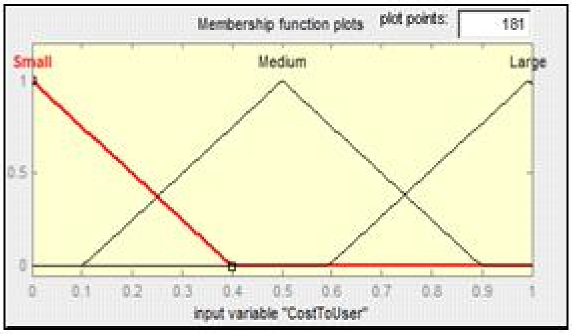

Fig 4: Member Ship Function for the Input Variable Cost

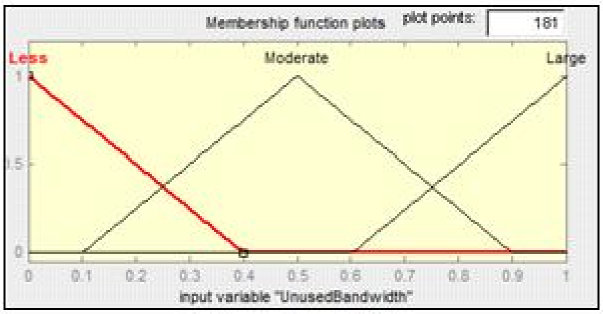

Fig 5: Member Ship Function for the Input Variable Unused Bandwidth

Table 1 shows the membership degrees for each of the base stations. In this table the first subscript denotes the input parameter and the second subscript denotes the BS.

TABLE 1
MEMBERSHIP DEGREES AND HANDOVER DECISION FOR EACH B.S

	BS_1	BS_2	--------	BS_n
Signal Strength	$\mu_{1,1}$	$\mu_{1,2}$	----------	$\mu_{1,n}$
Cost	$\mu_{2,1}$	$\mu_{2,2}$	-----------	$\mu_{2,n}$
Unused Bandwidth	$\mu_{3,1}$	$\mu_{3,2}$	----------	$\mu_{3,n}$
Handover Decision	F_1	F_2	-----------	F_n

The weight vector for 3 membership degrees can be given as

$$W = (w_1, w_2, w_3) \qquad (1)$$

and

$$w_i = \frac{\sigma_i}{\sum_{i=1}^{3} \sigma_i} \qquad (2)$$

or

$$W = (w_1, w_2, w_3) = \left[\frac{\sigma_1}{\sum_{i=1}^{3}\sigma_i}, \frac{\sigma_2}{\sum_{i=1}^{3}\sigma_i}, \frac{\sigma_3}{\sum_{i=1}^{3}\sigma_i} \right] \qquad (3)$$

where σ_i is the standard deviation of the membership functions $\mu_{1,1}, \mu_{1,2}, \_\_\_\_\_\_, \mu_{1,n}$ and is given by

$$\sigma_i = \sqrt{\frac{1}{n-1}\sum_{k=1}^{n}\left[\mu_{i,k} - \frac{1}{n}\sum_{k=1}^{n}\mu_{i,k}\right]^2} \qquad (4)$$

For the i_{th} BS (1 d” i d” n), its membership degree vector are given as

$$\mu_i = \begin{bmatrix} \mu_{1,i} \\ \mu_{2,i} \\ \mu_{3,i} \end{bmatrix} \qquad (5)$$

Now the handover decision for the i_{th} Base station BS_i is given by

$$F_i = W\mu \qquad (6)$$

or it can be given as

$$F_i = w_1\mu_{1,i} + w_2\mu_{2,i} + w_3\mu_{3,i} \qquad (7)$$

The handover decision vector can be given as

$$F = (F_1, F_2, F_3, ---F_n) \qquad (8)$$

With the handover decision vector F, the final vertical handover decision can be achieved with the following procedure and if it satisfied both the given conditions. For the i_{th} base station BS_i to be selected it should satisfied

{1} $F_i = \max.(F_1, F_2, F_3, ---F_n)$;

{2} $F_i - F_j \geq F_{TH}$,

Where

$$Fj = \max.\{F_1, F_2, F_3 - - - - - F_{i-1}, F_{i+1}, - - - - F_n\}$$

F_{TH} is the threshold handover decision value. It is used **to** avoid unnecessary vertical handovers. Then BS_i is the final base station BS_i chosen for handover.

V. RESULTS AND DISCUSSION

In this model we have considered 4 base stations BS_1, BS_2, BS_3 and BS_4. Table 2 shows the membership functions of the 4 base stations for their 3 input parameters.

TABLE 2
MEMBERSHIP DEGREE VALUES AND HANDOVER DECISION FOR EACH BS

	B.S 1	B.S 2	B.S 3	B.S 4
Signal Strength	.3	.9	.1	.4
Cost	.8	.2	.1	.5
Unused Bandwidth	.6	.8	.1	.5
Handover Decision ; F	.53	.69	.11	.47

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From these values of the membership function for each parameter the value of handover decision is calculated. For example consider the case B.S 2 the membership values for the parameters Signal Strength, Cost and Unused Bandwidth are .9, .2, and .8 respectively. From theses membership values the weight vector is calculated for each of the input parameters with the help of equation (2), equation (3) and equation (4). After calculating weight vector for each of the input parameter we can now find the handover decision is for each base station. From the table 2 we can see these values are .53, .69, .11, and .47 for BS_1, BS_2, BS_3 and BS_4 respectively. From these values the maximum value $F_{[max.]}$ is .69 and $F_{[max.]-1}$ is .53 and now we have to find that the difference between these two values should be equals to or greater than F_{TH} , where is the threshold handover decision value and is used to avoid unnecessary handoff. The difference of these two values is .16 and we assume that this value is greater than and so now the BS_2 is selected for handover. And if the difference is less than then the mobile will remains in its current BS and there will be no handoff. Table 3 shows the membership functions of the 4 base stations for their 3 input parameters for different scenario. In this case the difference between $F_{[max.]}$ and $F_{[max.]-1}$ is less than so in this case there will be no handoff and the mobile will remain in its current BS. Figure no. 6, 7 and 8 shows the surface curves between various input parameter and output handoff decision.

TABLE 3
MEMBERSHIP DEGREE VALUES AND HANDOVER DECISION FOR EACH BS

	B.S $_1$	B.S $_2$	B.S $_3$	B.S $_4$
Signal Strength	.8	.1	.7	.2
Cost	.9	.3	.8	.3
Unused Bandwidth	.7	.6	.6	.4
Handover Decision ; F	.2592	.8242	.7243	.2717

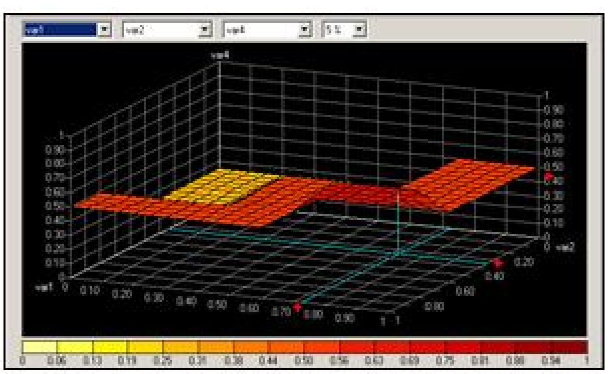

Fig 6: Surface Curves between Signal Strength, Cost and Output Handover Decision

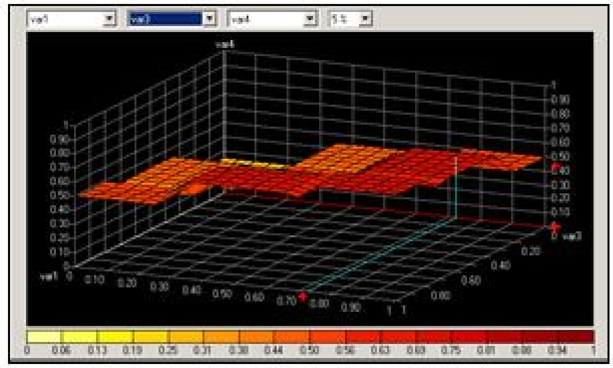

Fig 7: Surface Curves between Signal Strength, Unused Bandwidth and Output Handover Decision

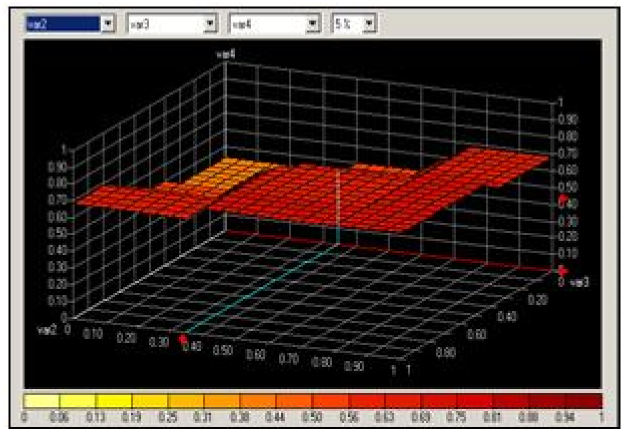

Fig 8: Surface Curves between Cost, Unused Bandwidth and Output Handover Decision

CONCLUSION

In this paper we have presented we have presented an intelligent vertical handover algorithm in heterogeneous wireless networks. Our proposed vertical handover algorithm considers some network parameters including signal strength, cost and unused bandwidth. The handover decision is based on the weight vector for each of the input parameter and membership function of each parameter. We can also plan to choose different factors as the input parameters to see if these changes can affect the service quality in wireless system. We can also plan to use neural method to intelligently decide the weights and satisfy the dynamic network conditions in the future work.

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